

Observations, Explanations and Open Questions in hard-scattering at RHIC.

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One of the major, arguably *the* major, discovery at RHIC is the suppression of π^0 with $p_T \geq 3$ GeV/c by a factor ~ 5 in Au+Au central collisions at $\sqrt{s_{NN}} = 200$ GeV, where in p-p collisions the production in this p_T range is due to hard-scattering of the constituents of the nucleon as described by QCD. The suppression had been predicted in advance to be the result of Landau-Pomeranchuk-Migdal coherent (gluon) bremsstrahlung by the outgoing hard-scattered partons traversing the medium produced in Au+Au collisions, which is sensitive to the properties of the medium. Further evidence that the suppression was indeed due to the medium was given by the non-suppression (with respect to the point-like scaling of hard-scattering) of direct photons which do not interact with the medium. However, as more detailed measurements in Au+Au collisions became available, the clarity of the previous explanation became obscured. Prompt e^\pm production from the decay of mesons containing the heavy quarks, charm and beauty, exhibited the same suppression as π^0 (which are produced by light quarks and gluons), naively arguing against the bremsstrahlung explanation. Measurements of π^0 suppression as a function of the reaction plane and centrality revealed a ~ 2 fm spatial or temporal region where no suppression occurs. Recombination models of the other exciting effect in the range $2 \leq p_T \leq 4.5$ GeV/c, the large \bar{p}/π ratio ~ 1 , a factor of 3-5 larger than exhibited by known jet fragmentation in p-p collisions, failed to explain the jet like structure associated to the \bar{p} , which is essentially the same as that for mesons in both the near and far hemispheres. Preliminary results of direct photon production for $p_T \approx 20$ GeV/c appeared to indicate a suppression approaching that of π^0 . These new results raised a host of questions that remain to be answered. For instance: since no measurements exist, are structure functions in nuclei as a function of centrality really understood? Do partons lose energy continuously or discretely in the medium? Do a significant number of partons exit the medium without losing energy? Are there really monojets in d+Au collisions? etc. These and other questions will be discussed together with the measurements that give rise to them.